Indian Stock Market Volatility and Economic Fundamentals : MIDAS Approach

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Abstract

Since the onset of endogenous growth theory, financial development has remained a centre place among policymakers and academicians for its multifold roles in accumulation of productive assets in an economy. Parallelly, the capital market has also provided advantages to the stakeholders through diversification of risk, amelioration of liquidity risk, discovery of asset prices, etc. In this regard, numerous studies have tried to capture the dynamics of stock markets across countries and within countries. The literature mentioned that the macroeconomic fundamentals have varying roles in predicting the behavior of stock markets. Most of the existing literature utilized the data set of comparable frequencies that is maximally available at the monthly level. However, the extent of volatility measurement of stock markets using high frequency data as of stock markets along with low frequency data as of macroeconomic indicators was overlooked in the Indian stock market. In this background, the present study took motivation to capture the roles of macroeconomic variables in explaining the volatility of the Indian stock market using the recently developed MIDAS GARCH approach. The study observed that macroeconomic variables such as exchange rate, money supply, treasury bills rate, along with the controlling variables of net foreign institutional investment and stock turnover ratio had predictable capacity for stock market volatility.

Key words : **macroeconomic indicators, stock market, volatility, MIDAS GARCH**

JEL Classification : G120, G140, G170

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With the invent of endogenous growth theory, financial development has got considerable attention for wide ranging implications towards capital accumulation, channelization of savings into productive purposes, ameliorating the asymmetry of information and moral hazard problems, adjustment to the liquidity risks, and risk diversification. Herein, financial markets play a vital role in affordable access to finance to the aspired economic agents from domestic and international investors (Marone, 2003), less reliance on bank finance, and a window for foreign capital inflows (Yartey, 2008). Moreover, it helps in better price discovery of securities, thereby easing the economic agents to rationalize the decision-making process and allocating the financial resources more efficiently with varying risk exposure. Besides, in theory, a stock market is identified as an information market primarily reflecting the conditions of economic environment. In general, well-organized stock markets perform their allocative and disciplinary tasks effectively and directly contribute to the welfare of the economy by providing needed liquidity to market participants (Laopodis & Papastamou, 2016). This very phenomenon motivated the researchers to understand the rationality of financial markets and its dynamics more

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rigorously. In this backdrop, researchers could identify the linkage between equity prices and macroeconomic environment embodied in variables such as GDP, industrial production, interest rate, inflation, etc. The theoretical motivation for this relationship lies in the dividend discount model (DDM), capital asset pricing model (CAPM), and asset pricing theory (APT) model. These models provide the logical basis of linkage between macroeconomic environment and stock prices. As per the APT theory, future cash flow is determined by the factors which characterize the environment affecting the corporate world. For practical purposes, this environment is best approximated by macroeconomic variables. In the CAPM framework, equity prices are determined by systemic risk also known as security beta. The information on systematic risk is also best gained from the macroeconomic environment.

In the early finance literature, the first moment of stock prices was extensively utilized for understanding the role of macroeconomic fundamentals. However, the changes in return dynamics were actively pursued after the onset of the pioneer work of Schwert (1989) wherein time-varying stock return volatility was explained by means of the time-varying volatility of macroeconomic and financial variables. Since then, volatility measurement and its possible determinants have gained considerable interest in the finance literature. Stock return volatility has been considered as a basic building block for a number of literatures, such as those relating to market efficiency, asset allocation, and risk management. High stock volatility is potentially undesirable for both investors and firms (Bushee & Noe, 2000). It is critical for policy makers to reduce the stock market volatility and ultimately enhance economic stability in order to improve the effectiveness of the asset allocation decisions (Poon & Tong, 2010). With increasing exposure of investors amid volatile markets, it is imperative to understand the financial markets' volatility dynamics.

In this regard, varying methodologies have been advanced for capturing the volatility dynamics. This volatility measurement was confined due to mismatch frequency of economic variables and stock market indicators. In fact, frequencies of economic variables are limited to monthly observations ; whereas, stock indicators on observed on a daily basis. In such a situation, the concordance between economic variables and stock market indicators are carried out by averaging the daily values of stock market performance. However, the very approach restricts the researchers to use large frequency data, particularly the stock performances, which, in turn, gives rise to the possibility of understating or overstating the volatility. In this regard, the most notable development took place with the pioneer work of Ghysels, Santa - Clara, and Valkanov (2004) introducing the (Mi)xed (Da)ta (S)ampling (henceforth MIDAS) approach for transforming a high-frequency variable while preserving the full information.

The Indian stock market has also witnessed the varying approach of volatility measurement, but the extent to which stock volatility responds to macroeconomic fundamentals in the preview of MIDAS approach has been overlooked. The Indian stock market having market capitalization of U.S. $ 1.4 trillion and turnover of U.S. $ 100 billion plus during 2014-16 puts forth enormous scope for understanding the volatility dynamics. With this motivation, the present study intends to diagnose the role of volatilities of economic variables in explaining the stock market volatility. The present study adds to the research knowledge in terms of volatility measurement through recently developed methods and identifies the long-run relationship between estimated economic volatility and financial market volatility. Having an understanding of this phenomenon may prevent significant losses to the investors and boost confidence in investors for making the financial market more resilient.

Review of Literature

The finance literature underscores the rationalization of financial market performance through macroeconomic fundamentals. The association between the two dates back to dividend discount model (DDM). This theoretical behavior was further extended to the capital asset pricing model and arbitrage pricing theory. In the wake of these theoretical underpinnings, empirical literature has well quantified the relation between equity prices and

economic variables. To the first, it was assumed that the stock prices are determined by discounted cash flow abilities of a firm. To a great extent, cash generating capabilities have a great association with the overall economic growth scenario of the economy approxied by gross domestic product (GDP) or industrial output. Another indicator reflecting the real economic activity includes inflation capturing the demand and supply responses. Empirical evidence suggested that high levels of inflation generate greater uncertainty which, in turn, increases the risk premium demanded by investors for holding equity, hence decreasing the stock prices (Malkiel, 1979). Also, higher inflation prompts for enacting monetary policy by controlling interest rates which hamper investment and economic growth, thereby making the stock market volatile. Fama (1981) used the money demand theory to demonstrate a strong negative relation between expected inflation and anticipated real activity. Stock returns were shown to be positively related to future real variables. Consequently, the negative relation between stock returns and expected inflation prevailed.

On the monetary policy front, money supply has been treated as an important component for changes in the stock prices (Rozeff, 1974). According to the liquidity preference hypothesis, an increase in the money supply is expected to lower the interest rate, thus raising the stock prices (Patra & Poshakwale, 2006). Growth in the money supply increases liquidity and greater demand for securities amid lower interest rates. Interest rate assumes negative relation with the stock market as lower rates put forth the scope for investors to actively participate in the stock market, and hence, there is scope for better price discovery through enhanced competition. Another macroeconomic variable of interest is the exchange rate since currency movements expose firms to substantial financial risks. Appreciation of exchange rate makes a product uncompetitive and thereby causes loss to the exporting industry and gains to the importing industry. On the other hand, appreciation of currency adjusts the exchange rate risk and invites higher foreign investment, leading to better functioning of the stock market. Moreover, in case of appreciation, firms need not indulge into hedging strategies, and thereby reduce costs. Several strands of finance literature quantified the relationship between macroeconomic fundamentals and financial markets' performance. Most notable include Fama and French (1989) and Roma and Schlitzer (1996) among others. Few other recent studies are Humpe and Macmillan (2009) for USA and Japan ; El - Wassal (2005) for emerging stock markets (ESM) ; Ahmed (2008) for India ; Inegbedion (2012) for Nigeria, among others.

On the stock market volatility front, Schwert (1989) obtained empirical results towards a positive linkage between macroeconomic volatility and stock market volatility, with the direction of causality being stronger from the stock market to the macroeconomic variables. Hamilton and Lin (1996) underscored the economic recession as the most important factor influencing the stock volatility; David and Veronesi (2004) identified inflation and earnings uncertainty as sources of stock market volatility. For 21 emerging markets, Harvey (1995 a, b) concluded that domestic variables were the key sources of volatility instead of global factors. Campbell, Lettau, Malkiel, and Xu (2001) found that volatility moved counter-cyclically with respect to GDP.

Engle and Rangel (2008) modeled low frequency volatility as a function of macroeconomic and financial variables and found that it is greater when the macroeconomic factors - GDP, inflation, and short-term interest rates are more volatile or when inflation is high and output growth is low. Volatility is higher for emerging markets and for markets with small numbers of listed companies and lower market capitalization relative to GDP. Mishra and Singh (2012) found industrial production and foreign institutional investment as influencing factors of stock returns volatility. Oseni and Nwosa (2011) stated that the volatility in interest rate and inflation rate did not significantly explain the volatility of the stock market. Kadir, Selamat, Masuga, and Taudi (2011) added that interest rate volatility had negative bearings on stock market volatility ; whereas, exchange rate volatility had a positive effect.

Zakaria and Shamsuddin (2012) evidenced that the stock market volatility and macroeconomic volatility did not exhibit the relationship pattern among the two indicators. Mohanamani and Sivagnanasithi (2014) revealed that the Indian stock market was positively associated with inflation, money supply, and industrial productivity;

however, exchange rate and inflow of foreign institutional investments were found to be insignificant to the Indian stock market. Kumari and Mahakud (2015) measured the Indian stock market volatility using VAR approach and concluded a linkage between macroeconomic volatility and equity market volatility. De and Chakraborty (2015) tried to understand the linkage between foreign portfolio investment and stock market volatility in India using the data set for the period from 2003-13; however, statistical results did not confirm the significant causal relationship between the two indicators. While considering a broad range of economic variables, Gurloveleen and Bhatia (2015) revealed that only foreign institutional investments and exchange rate had a significant impact on the Indian stock market performance. In the Indian context, it was empirically investigated that the index of industrial production was a significant predictor of Bombay Stock Exchange market of India. However, foreign direct investment and inflation were not found to be significant predictors of the market (Tripathi, Singh, & Singh, 2016). In the same fashion, Giri and Joshi (2017) evidenced that economic growth, inflation, and exchange rate influenced stock prices positively; however, crude oil price influenced the stock prices negatively. Chowdhury and Anuradha (2018) contented that the currency value is one of the reasons of short term fluctuation in the Indian stock market. Hence, it is observed from the existing review that there is no conclusive statement about the relationship between stock market volatility and volatility of macroeconomic variables.

Engle and Rangel (2008) introduced the Spline - GARCH model, which separates market volatility into two components, a short-term and a long-term one, and then demonstrates that the latter is highly correlated with the business cycle. The study considered a panel of 50 countries and evidenced that inflation, GDP, and short - term interest rates were the significant determinants. Recessions and inflationary episodes led to an increase in the long - term market variability component. In addition to that, the authors observed volatility's propensity to be higher in emerging markets and to be negatively correlated with market capitalization and the number of listed companies. In continuance, Engle, Ghysels, and Sohn (2009) developed the GARCH - MIDAS model and decided to test it on the same data Schwert used in his study. They discovered a correlation between the variability of the index, inflation, industrial production, monetary base, and interest rate spread.

The MIDAS approach has gained much presence in empirical literature for having an advantage in terms of producing lower out-of-sample root mean square forecast errors (RMSFEs) than benchmarks and ignoring high frequency information. Few of the studies such as Andreou, Ghysels, and Kourtellos (2013) ; Carriero, Clark, and Marcellino (2015) ; and Kuzin, Marcellino, and Schumacher (2013) utilized the MIDAS approach for understanding the dynamics of real economic activity growth ; whereas, Ghysels et al. (2007) and Ghysels and Valkanov (2012) utilized for stock market volatility. Other studies, that is, Engle et al. (2013) and Schorfheide et al. (2014) considered this approach for identifying the relation between stock market volatility and macroeconomic activity.

Apart from the above literature, the most - recent pragmatic relation between economic fundamentals and stock market volatility can be well evidenced through the announcement of fed tapering - to monthly purchase of the U.S. $ billion bonds by the Central bank instead of U.S. $ 85 billion amid the revival sign of the U.S. economy, which has created substantial bubbles in emerging stock markets. Few other instances such as global financial crisis, sovereign debt crisis, China's slow down, and falling international oil prices, etc. have also made the global financial indices volatile. These happenings have made it pertinent that policymakers, and in particular, financial investors provide a safeguard to the economy, and thereby, place the scope for understanding the financial markets' dynamics. In this context, the present study intends to diagnose the empirical relationship between the two dimensions for the Indian market and draws inferences about the direction and magnitude of stock volatility caused by economic fundamentals.

To the best of our knowledge, the estimation of volatility for the Indian stock market through MIDAS GARCH approach and its macroeconomic determinants are beyond the coverage of existing finance literature, and the present study is an attempt to cover this research gap. The present study extends the existing literature in terms of

measuring volatility for each variable using the recently developed method for high-frequency data, and then identifies the long-run relationship between estimated economic volatility and financial market volatility.

Research Methodology

The stock returns and macro-economic variable relations have been captured by various econometric models starting from regression models to vector auto regression to error correction modeling to auto regressive distributed lag model, etc. All these models are suitable for the same frequency data. However, the stock market volatility has been measured by auto-regressive and moving average (ARMA, ARIMA), auto-regressive conditional heteroscedasticity (ARCH, GARCH), etc. In this process, the high-frequency data mainly available for stock prices is averaged to have compatibility with the macroeconomic fundamentals largely available on a quarterly or yearly basis, which thereby limits the researchers to derive the real information from high-frequency data. In order to account for such behavior, (Mi)xed (Da)ta (S)ampling (henceforth, MIDAS) has been introduced by finance literature. Mixed data samples are treated in two processes, first- aggregation of the highest frequency data to bring it to the similar frequency of targeted variable, and then to perform the auto regressive distributed lag model (ARDL) with pre-filtered data (Ghysels et al., 2004).

In the context of India, a few studies could account for the relationship in the presence of different sampling frequencies' data. In the present study, we utilize the MIDAS (mixed data sampling) GARCH approach for capturing the volatility of individual indicators, and then the ARDL bounds-testing approach is utilized for estimating the causal relationship between stock market volatility and other economic variables.

(1) Research Methods : The effects of macroeconomic variables on the long-run stock volatility are investigated by using the GARCH - MIDAS model of Engle et al. (2013). For the purpose, a two stage process is adopted. In the first stage, long run volatility is estimated by using the GARCH - MIDAS approach and in the second stage, the estimated volatility is regressed against macroeconomic variables in the forms of both their level and estimated volatility. The volatility of macroeconomic variables is estimated in the form of conditional variance by fitting the GARCH model. The brief description of the GARCH - MIDAS model is as under :

The stock return at day $i = 1, \ldots\ldots\ldots N_t$ in month t follows the process :

$$r_{i,t} = \mu + \sqrt{\tau_t g_{it}}\varepsilon_{it} \qquad \forall i = 1,2,3,\ldots\ldots\ldots, N_t \qquad (1)$$

$$\varepsilon_{i,t} / \phi_{i-1,t} N \approx (0,1)$$

where, N_t is the number of trading days in month t and $F\,i\text{-}1, t$ is the information set up to $(i\text{-}1)$th day of period t. Equation (1) expresses the variance into a short term component defined by $g_{i,t}$, and a long term component defined by τ_t.

The conditional variance dynamics of component $g_{i,t}$ is a (daily) GARCH (1,1) process, as :

$$g_{i,t} = (1 - \alpha - \beta) + \alpha \frac{(r_{i-1,t} - \mu)}{\tau_t} + \beta g_{i-1,t}$$

and τ_t is defined as smoothed realized volatility in the spirit of MIDAS regression :

$$\tau, t = m + \theta \sum_{k=1}^{K} \varphi_k(\omega_1, \omega_2) RV_{t-k}$$

$$RV_t = \sum_{i=1}^{N_t} r^2_{i,j}$$

To investigate how secular volatility is related to macroeconomic environment, the following regression model is estimated :

$$\log o\,\tau,t = C + \sum_{i=1}^{5}\sum_{j=0}^{p}\theta_{ij}X_{it\text{-}j} + \sum_{i=1}^{5}\sum_{j=0}^{p}\phi_{ij}X^{v}_{it\text{-}j} + \pi Turn + \omega NFII + \sum_{i=1}^{m}\gamma_i \log\tau_{t-1} + \upsilon_t$$

where, X_{it} are the macroeconomic variables including index of industrial production (IIP), inflation (INF), exchange rate (EXCH), treasury bills rates (TRE91), liquid liabilities (M3) for i =1, 2, … 5 and X_{it}^{v} are the volatilities for the same variables. Turn is the log of stock turnover ratio and NFII is the net foreign institutional investment.

(2) Variables and Data Sources : The study utilizes the daily data of the 'Sensex' (an index of Bombay Stock Exchange) for measuring stock market volatility. After extensive review of existing literature in the concerned field, the study considers index of industrial production (IIP) and inflation (INF) as proxies for real economic activities, money supply (M3) and interest rate as proxies for stance of monetary policy, exchange rate (EXCH) for accounting the external imbalances emanated from the trade performance, stock turnover ratio as an indicator of market liquidity, and foreign investment as a proxy for business expectation and confidence building among foreign players. Interest rate is approximated by 91 days treasury bills rates. Net foreign investment and stock turnover are used as control variables.

The macro - economic variables' data were available on a monthly basis. The study uses the monthly data for a time span ranging from October 1993 to May 2015 considering the availability of widest data length of macro variables on a particular base year. The underlying reason is that we could extract the maximum frequency of data for economic indicators using base year as 2004 - 05. The data for economic indicators are available beyond 2015 albeit with a different base year as India has recently revised the base year to 2011-12. Furthermore, the data for the new base year were available only for the past 6 - 7 years. Hence, the study uses the data upto 2015. To compute the long run volatility of the stock index for the same period, the daily data from 1992 to 2015 were utilized and the data points before October 1993 were used as lagged values in the MIDAS GARCH process. The data were sourced from *Handbook of statistics on Indian economy* (various issues) publications of Reserve Bank of India, and from website of the Bombay Stock Exchange.

Analysis and Results

The daily returns of index for the period of 1993 to 2014 were utilized to extract secular's volatility. The GARCH-MIDAS model with K = 180 based on AIC provides the best fit for the given data based on AIC and so used to obtain the rolling-window smoothed stock market volatility also known as long run components. Both long run and short run components are plotted in the Figure 1. Compared to long-run secular volatility, conditional volatility is much observed in the Indian stock market. The effects of global shocks are visible in stock volatility.

The Table 1 presents the estimates of the model. The estimated results include the parameters where the value of 'w' close to 1 indicates that the attributes of optimality and monotonically decline with lags. The value of alpha plus beta is 0.956, which is less than 1, the ω is the value of ω2, the weight of beta distribution where ω1 is assigned with 1.

The Table 2 presents the correlation among the level form of economic variables and estimated volatility of both macroeconomic variables and stock market returns. It is observed that long term estimated market return volatility is much associated with exchange rate (dominated by level form), money supply, and net foreign institutional investments. Industrial production has negative bearings with the exchange rate and positive bearings with money

Figure 1. Conditional Volatility and its Long Run Component of Stock Market Returns

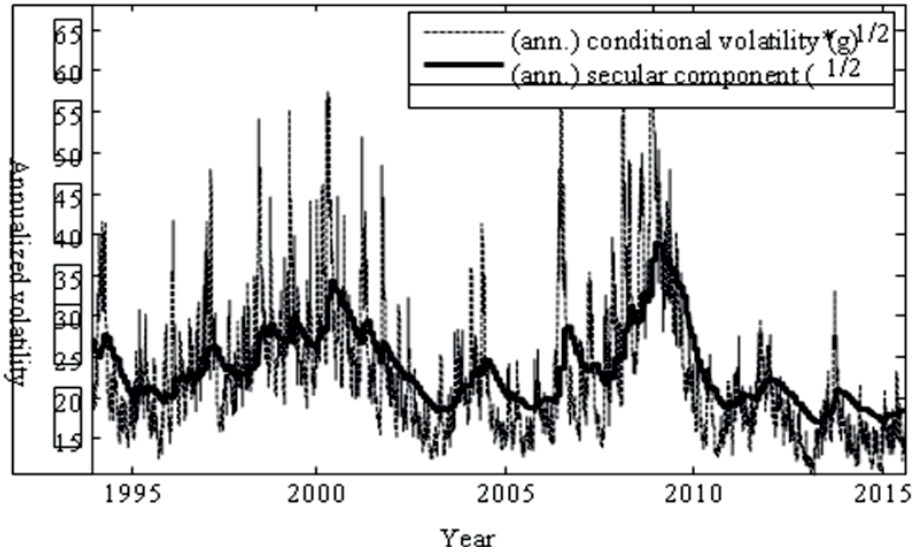

Table 1. Parameter Estimates for GARCH-MIDAS with Realized Variance

	μ	α	β	θ	ω	*m*
Estimates	0.0896	0.1087	0.8471	0.1755	3.0253	0.8878
S.E.	0.0172	0.0103	0.0169	0.0147	0.7281	0.1147
***T*-stat**	5.21	10.50	50.21	11.90	4.16	7.74

Likelihood = -9255.14

Table 2. Correlation Among Market Volatility and Macroeconomic Variables' Volatility

	LTAUM	IIP	IIPV	EXCH	EXCHV	M3	M3V	INF	INFV	TRE91	TRE91V	NETFII	LTUR
LTAUM	1.000												
IIP	-0.015	1.000											
IIPV	-0.103	-0.148	1.000										
EXCH	-0.369	-0.542	0.321	1.000									
EXCHV	-0.018	-0.280	0.474	0.363	1.000								
M3	0.624	0.278	0.141	-0.492	-0.097	1.000							
M3V	-0.002	0.413	0.081	-0.238	-0.080	0.229	1.000						
INF	0.020	0.221	0.057	-0.369	0.104	0.194	0.124	1.000					
INFV	0.109	0.214	-0.060	-0.386	-0.061	0.129	0.312	0.351	1.000				
TRE91	-0.064	0.044	0.078	-0.208	0.116	-0.033	0.163	0.269	0.344	1.000			
TRE91V	0.105	-0.031	0.098	-0.027	0.201	0.108	0.020	0.035	-0.048	0.113	1.000		
NETFII	-0.321	-0.096	0.280	0.331	0.113	-0.225	-0.117	-0.102	-0.092	-0.150	-0.045	1.000	
LTUR	0.063	-0.157	0.394	0.589	0.214	0.062	-0.049	-0.110	-0.348	-0.473	-0.061	0.210	1.000

Note: LTAUM is the long-run stock market volatility, IIPV represents the volatility in index of industrial production (IIP) and so on for variables where '*V*' is added. EXCH is the exchange rate, M3- liquid liabilities, INF- inflation, TRE91 : Treasury bills rates, NETFII - net foreign institutional investment, LTUR is the log values of stock turnover.

Table 3. Economic and Stock Market Variables (US $ Billions)

Year	Exchange Rate*	Exports	Imports	Market Capitalization	Turnover	Net FII	WPI**
1995-98	36.4	31.2	28.6	136.6	29.9	1.7	123.6
1999-02	45.9	38.6	36.3	144.2	125.0	1.4	150.8
2003-06	45.3	69.6	72.1	360.0	119.0	7.6	181.4
2007-10	44.7	137.7	178.0	1006.1	280.7	9.1	227.0
2011-13	52.9	233.0	308.3	1239.5	151.6	19.0	291.6
2014-16	64.1	245.5	297.5	1402.4	108.6	10.2	334.4
			Growth Rates (%)				
1995-98	7.2	12.5	18.0	4.3	33.6	-2.2	7.4
1999-02	4.2	5.1	3.1	4.3	30.8	-379.4	5.0
2003-06	-1.7	21.7	29.8	57.9	32.6	384.8	5.0
2007-10	0.6	13.8	18.5	32.9	20.2	-109.8	5.8
2011-13	8.7	18.1	18.5	-6.1	-31.3	30.2	8.6
2014-16	4.7	-1.0	-2.7	10.3	9.2	-41.1	1.8

Source: Compiled from Reserve Bank of India, Note: * ₹ vs $, ** Base 1993 - 94

supply and inflation, and it is intuitive. Expansion in industrial output signals a favorable economic environment, thereby boosting the foreign investors to park their money, resulting into gain in the exchange rate. The positive relation with inflation suggests a demand led inflation scenario in the country. Industrial volatility has a positive go with exchange rate (dominated by exchange volatility). Exchange rate and money supply & inflation are negative correlated. The negative inflation relation indicates that depreciation of currency makes imports cheaper and thus lowers the inflation. Exchange rate and turnover ratio exhibit positive move as depreciating currency might be putting active pressure on trading amid exchange rate risk. Exchange rate volatility and treasury bills rates & turnover ratio report positive direction to each other. This situation may be attributed to the risk averter behavior of investors amid volatile exchange markets and safeguarding the investments while parking in risk-free securities. Inflation and treasury yields have positive bearings, highlighting that India has experienced high inflation in the past decade, and in order to control the inflation, active policies have been implemented by the Central bank time and again. Higher benchmark rate might be prevailing in treasure yields as well.

The Table 3 presents the descriptive behavior of economic fundamentals and stock market indicators. One interesting observation is that the growth rate of imports has been high compared to the growth rate of exports in the majority of the sample period. This growth has remained robust even in case of falling rupee against the U.S. dollar. Ideally, each depreciation level might make exports competitive, but it has not been proved in the Indian market. Very recently, the imports came down, the reason may be that the Indian rupee came down to the historic low level of ₹ 64.1 during 2014-16. Also, foreign institutional investments have been in tandem with the exchange rate, reporting highest growth during the appreciation period of the Indian currency (2003-06). Net FIIs fell drastically from U.S. $ 19 billion during 2011-13 to U.S. $ 10.2 billion during 2014-16, particularly in the lowest phase of the Indian currency.

(1) Relationship Between Stock Market Volatility and Economic Growth : The growth in index of industrial production (IIP) serves as a proxy for overall growth in the economy. Table 4 highlights the short-run and long-run coefficients for impact of macroeconomic variables - both level form as well as volatility on stock market volatility. Gross domestic product (GDP) influences stock returns through its impact on corporate profitability. An

Table 4. Autoregressive Distributed Lag Estimation

(Dependent Variable Estimated Market Volatility)

Short-Term Coefficient				Long-Run Coefficient			
Variables	**Coefficient**	***t* - statistics**	***P* - values**	**Variables**	**Coefficient**	***t* - statistics**	***P* - values**
C	-0.241	-2.242	0.026	*C*	-3.526	-2.296	0.023
IIP	-0.004	-2.475	0.014	IIP	-0.059	-2.544	0.012
INF	-0.005	-2.107	0.036	INF	-0.069	-2.133	0.034
EXCH	-0.005	-3.074	0.002	EXCH	-0.075	-3.048	0.003
M3	0.003	0.952	0.342	TRE91	0.081	1.538	0.125
TRE91	0.006	1.611	0.109	M3	0.043	1.039	0.300
IIPV	-0.003	-1.589	0.113	IIPV	-0.038	-1.646	0.101
INFV	-0.013	-1.113	0.267	INFV	-0.196	-1.030	0.304
EXCHV	0.006	2.584	0.010	EXCHV	0.087	2.443	0.015
M3G	0.070	2.220	0.027	M3V	1.031	1.858	0.064
TRE91V	0.030	2.345	0.020	TRE91V	0.443	2.107	0.036
LTUR	0.031	2.995	0.003	LTUR	0.449	3.002	0.003
NETFII	0.000	-2.817	0.005	NETFII	-0.004	-2.528	0.012
LTAUM(-1)	1.369	25.360	0.000				
LTAUM(-2)	-0.437	-8.222	0.000				
Adjusted R^2	0.977		0.597				
F-statistic	791.53			*D - W* Statistic - 1.98			

increase in output may increase expected future cash and, hence, raise stock prices, while the opposite effect would be valid in a recession. Herein, the counter cyclical relation between real economic activity and stock returns volatility is presumed. In the present study, it is found that index of industrial production significantly explains the market return volatility and it is counter-cyclical in nature. The result suggests that 1% rise in real economic activity reduces the stock market volatility by around 6% in the long-run.

(2) Relationship Between Stock Market Volatility and Inflation : Since the stock returns are measured in nominal terms, it is expected that volatility in inflation should translate into volatility in the equity returns. Empirical evidence suggests that high levels of inflation generates greater uncertainty which, in turn, increases the risk premium demanded by investors for holding equity, hence decreasing the stock prices (Malkiel, 1979). Campbell and Shiller (1988) pointed out that inflation raises corporate earnings and increases future expected dividends ; hence, there is a counter cyclical relation between inflation volatility and stock market volatility. However, there is also a second important effect of higher inflation rates through the discount rate (via the Fisher effect) in terms of lowering the stock prices and thus indicating a positive relation among the volatilities. Herein, mixed empirical evidence is documented in the literature for inflation and stock volatility. Boudoukh and Richardson (1993) empirically identified the negative relation in early finance literature of the 1970s. However, the recent literature identified positive relations between the two and indicated that stocks can indeed serve as long-term inflation hedge (Kolari & Anari, 2001).

In the present study, inflation significantly explains the market volatility, but with a negative sign, implying that higher inflation reduces volatility (Table 4). One possible explanation for such a phenomenon can be attributed to

the growing demand in the economy as a plausible cause for inflation in the midst of limited supply capacities. The correlation table identifies a positive association between IIP and inflation. In the context of India, particularly in the beginning of the 21st century, the pace of demand was robust, and the resultant inflation happened despite of parallel supply and other policy measures. In this condition, inflation might be perceived by investors as an optimistic behavior where the expansion of firm activities may take place. This phenomenon in-turn affects cash flow capabilities of firms, and accordingly lowers the stock market volatility. Megaravalli and Sampagnaro (2018) evidenced the negative but insignificant relationship between inflation and stock market for the Asian group (India, China, and Japan).

(3) Relationship Between Stock Market Volatility and Money Supply : Moving onto monetary parameters, the first candidate is obviously money supply. In case of money supply, the level variable is insignificant but volatility boosts the market volatility substantially (Table 4). These results are comparable with the findings of Hossain and Abedin (2017). Money supply may have positive as well as negative effects on stock prices. Higher money supply may create inflationary pressure which, in turn, increases the discount rate and lowers the stock prices. This behavior favors the positive association between inflation and volatility. On the other hand, excessive liquidity might be giving enough space for investors to actively participate in the financial market amid lower interest rate. A healthy competition would ameliorate the market anomalies and lead to a stable market with low volatilities. The correlation figures suggest that money supply has marginal negative relation with treasury bills rates. In case of India, the increase in money supply may not be lowering the interest rates in tune to the liquidity preference theory ; rather, the increased supply may be putting inflationary pressure which prompts for higher benchmark rate and accordingly ensures higher returns for treasury bills as well. This phenomenon suggests the positive relation between money supply volatility and stock market volatility. In this study, money supply volatility is found to positively affect the market volatility.

In case of money supply, the effect on the stock market can be guided through interest rates or exchange rates. The correlation table suggests a negative association between money supply and net FIIs, meaning that foreign investors take the exchange rate risk as priority, and hence create stock market volatility. The same is evidenced through the negative relation between money supply and exchange rate.

(4) Relationship Between Stock Market Volatility and Interest Rate : In terms of interest rates approxied by treasury bills rate for 91 days, it is found that level does not have a significant impact. However, the volatility in interest rate is making the stock market volatile. On an average, a 1% increase in interest rate volatility increases the stock market volatility by 4.4% (Table 4). Higher interest rates increase the opportunity cost to the firm. It may affect the profitability of firms and accordingly put the market into volatile behavior. In case of higher interest rate, the shifting of resources from equity markets to bonds market may take place, and hence, create a little volatility in the market.

(5) Relationship Between Stock Market Volatility and Exchange Rate : Another macroeconomic variable of interest is the exchange rate since currency movements expose firms to substantial financial risks. In general, the depreciation of exchange rate indicates a message of poor performance on the external front for a country and accordingly, the volatility in the stock market increases. There is a supposed positive relation between exchange rate and volatility. International economics literature asserts that the depreciation of currency renders exports competitive and imports uncompetitive. It indicates the negative relation between exchange rate and stock market volatility. In this case, the exporting industry may have higher stock prices which may create a stable stock market. On the other hand, appreciation of exchange rate adjusts the exchange rate risk and invites higher foreign investment, leading to better functioning of the stock market. Herein, the appreciation of currency would be

lowering the market volatility. Moreover, in case of appreciation, firms need not indulge into hedging strategies, thereby reducing costs to firms.

In terms of exchange rate, the results indicate that both level and volatility influence the stock market volatility. The level form is negatively associated with market returns ; however, the exchange volatility positively influences the stock volatility. On an average, the depreciation of exchange rate by 1% reduces the market volatility by 7.5% (Table 4). This phenomenon may be attributed to the fact that the Indian currency exchange rate has been a bit overvalued in the recent past (Aiyar, 2014). In case of India, the recent past phenomenon mentions that the currency has been depreciating since long. Even the depreciation could not increase the exports greatly ; rather, imports have grown faster. However, the falling exchange rate might have created an uncertainty among the foreign investors, resulting into a pulling back of capital and rendering the stock market volatile. The pass through the effect of currency depreciation in India is not realized in full swing. The net impact depends on the optimization of exchange rate. Indian exchange rate is somehow treated as overvalued and any depreciation would be adjusting the market disequilibrium and providing a stance of improvement in competitiveness of the country, leading to better confidence building among investors and thereby lowering the stock market volatility. The depreciation of exchange rate may not be perceived by investors as a problem as an external imbalance and may lead to loss of confidence in economic fundamentals. Moreover, a volatile stock exchange rate has a positive impact on stock market volatility. Chowdhury and Anuradha (2018) produced similar results in the Indian context. As per the results, a 1% rise in exchange volatility causes a 8.7% increase in market volatility. Muthike and Sakwa (2012) identified the negative impact of currency appreciation on the domestic stock market through the impact of profitability.

(6) Stock Market Volatility and Foreign Investments & Stock Turnover : The present study utilizes foreign investment and stock trading as control variables. On the foreign investment front, the net foreign institutional investment is considered and the estimated volatility significantly negatively influences the stock market volatility. Stock traded to market capitalization called as the turnover ratio captures liquidity in the stock market (Garcia and Liu, 1999). The volatility in the turnover ratio adds on to the stock volatility significantly (Table 4). These results are aligned with the previous finance literature.

In sum, the results presented have certain real life implications. From the findings of the study, it can be concluded that the internal environment of higher economic growth and stable monetary measures such as money supply, interest rate, and inflation play a very important role in stabilizing the Indian stock market. The external environment's volatility captured through fluctuations in exchange rate and foreign investment flows into India put the Indian stock market into a volatile condition. Hence, these findings can be utilized by stakeholders to safeguard their investment positions in the stock market of India.

Conclusion and Research Implications

In sum, the study captures the volatility for Sensex returns and macroeconomic variables through MIDAS GARCH approach, and explores the stock market volatility reasons. The ARDL bounds testing approach confirms the significant impact of level form of index of industrial production, inflation, and exchange rate on stock market volatility. The volatility in the stock market is also caused by volatility in macroeconomic variables such as exchange rate, money supply, treasury bills rate, along with the controlling variables - net foreign institutional investment and stock turnover ratio. The results of the present study are in consonance with the earlier finance literature except for exchange rate and inflation. The level of exchange rate and inflation are negatively associated with the stock market volatility. The possible reason for this phenomenon may be attributed to the fact that the

Indian exchange rate is somehow treated as overvalued and any depreciation would be adjusting the market disequilibrium. Depreciation of exchange rate provides a stance of improvement in competitiveness of the country and better confidence building among investors and thereby lowering the stock market volatility. On the inflation front, it can be argued that inflation may be an outcome of growing demand amid higher growth trajectory of India in the early decade of the 21st century. In this condition, inflation might be perceived as an opportunity by investors hoping for expansion of firm activities. This scenario, in turn, affects cash flow capabilities of firms, and accordingly lowers the stock market volatility. The study concludes that macroeconomic variables have predictable capacity for stock market volatility.

The study has captured the roles of macroeconomic fundamentals in explaining the volatility of the Indian stock market using dense information of BSE market contained in the daily data set. The findings of this study pave the way for investors and businesses towards understanding the market dynamics and thereby safeguarding against the changing market risks; and to the policymakers for proper regulation of the stock market.

Limitations of the Study and Scope for Further Research

The study has a limitation that amid the data constraints, it could not account for the impacts of recent macroeconomic fundamentals associated with key major reforms such as demonetization and goods and services tax (GST) launched in the past couple of years. Also, the determinants for sector-specific volatility are beyond the scope of the present study. However, the same put forth the scope for future research.

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